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Climate change and its possible security implications

Report of the Secretary-General**

Summary

Both governmental views and relevant research on the security implications of climate change, by and large, approach the question from a perspective of interdependence between human vulnerability and national security. They identify five channels through which climate change could affect security:

(a) **Vulnerability**: climate change threatens food security and human health, and increases human exposure to extreme events;

(b) **Development**: if climate change results in slowing down or reversing the development process, this will exacerbate vulnerability and could undermine the capacity of States to maintain stability;

(c) **Coping and security**: migration, competition over natural resources and other coping responses of households and communities faced with climate-related threats could increase the risk of domestic conflict as well as have international repercussions;

(d) **Statelessness**: there are implications for rights, security, and sovereignty of the loss of statehood because of the disappearance of territory;

(e) **International conflict**: there may be implications for international cooperation from climate change's impact on shared or undemarcated international resources.

* A/64/150 and Corr.1.

** The delay in the submission of the present report was due to extensive gathering of views of Member States and United Nations organizations on which the report is based in a short period of time between the adoption of the resolution mandating the report (3 June 2009) and the submission date.

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Climate change is often viewed as a "threat multiplier", exacerbating threats caused by persistent poverty, weak institutions for resource management and conflict resolution, fault lines and a history of mistrust between communities and nations, and inadequate access to information or resources.

The present report identifies several "threat minimizers", namely conditions or actions that are desirable in their own right but also help to lower the risk of climate-related insecurity. These include climate mitigation and adaptation, economic development, democratic governance and strong local and national institutions, international cooperation, preventive diplomacy and mediation, timely availability of information and increased support for research and analysis to improve the understanding of linkages between climate change and security. Accelerated action at all levels is needed to bolster these threat minimizers. Most urgently, a comprehensive, fair and effective deal in Copenhagen will help to stabilize our climate, protect development gains, assist vulnerable nations adapt to climate change and build a more secure, sustainable and equitable society.

Beyond this, the report identifies a set of emerging climate change-related threats which merit the focused attention and increased preparedness of the international community, namely, those that appear highly likely, are large in magnitude, may unfold relatively swiftly, and are unprecedented in nature, including: loss of territory, statelessness and increased numbers of displaced persons; stress on shared international water resources, for example, with the melting of glaciers; and disputes surrounding the opening of the Arctic region to resource exploitation and trade. This is not an exhaustive list, as new challenges may warrant the attention of the international community in future.

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I. Introduction

1. The present report has been prepared in response to the request of Member States, in General Assembly resolution 63/281, for a comprehensive report to the Assembly at its sixty-fourth session on the possible security implications of climate change, based on the views of Member States and relevant regional and international organizations. A total of 35 Member States, 4 Member State groups, and 17 regional and international organizations, including agencies and programmes of the United Nations, have made submissions to the Secretariat in reference to that resolution,[1] and the report endeavours to reflect those views in the light of the relevant research.

2. The nature and full degree of the security implications of climate change are still largely untested. The present report seeks to organize the views of Member States as well as relevant research on the subject in a framework that is evidence-based, drawing on the most recent available data and research, and most conducive to policy guidance. Its goal is to outline the possible channels through which adverse implications for human or national security might occur, what form they could take, and what combinations of actions could avert them. Its policy focus is first and foremost on ways in which possible security implications of climate change could be prevented.

3. The emphasis on prevention is consistent with the efforts of the United Nations to move from a culture of reaction to one of conflict prevention, as well as its emphasis on sustainable development as a crucial contributor to conflict prevention. Advancing sustainable development, building resilience to physical and economic shocks, and strengthening institutions will pay a double dividend — helping to confront climate change and promoting peace and security.

4. Authoritative studies of the economics of climate change such as *The Stern Review*[2] find that the costs of preventing dangerous climate change, while not trivial, are far outweighed by the eventual costs of unmitigated climate change. That result, moreover, does not take into account the difficult-to-measure but real costs of such "socially contingent" impacts of climate change as social and political instability, conflicts and involuntary migration, or the measures taken in response to these. Were those to be included, the cost advantage of prevention would be even greater — a message broadly consistent with my argument in successive reports that the prevention of violent conflict is far more cost-effective than remediation (see A/55/985-S/2001/574 and Corr.1; A/58/365-S/2003/888; and A/60/891).

5. Before examining the evidence on climate change and its security implications, a brief introduction is needed on definitional and methodological questions, namely, the concepts of human vulnerability and national security and the treatment of uncertainty.

6. The principal focus in the present report is on the security of individuals and communities. It reflects the spirit of many submissions from Member States and is

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[1] Submissions of those Member States that have not indicated otherwise are posted on the website of the Department of Economic and Social Affairs Division for Sustainable Development at http://www.un.org/esa/dsd/resources/res_docugaecos_64.shtml.

[2] Nicolas Stern, *The Economics of Climate Change: The Stern Review* (Cambridge University Press, 2007).

consistent with the suggestion of the *Human Development Report 1994* that, for ordinary people, "security symbolized protection from the threat of disease, hunger, unemployment, crime, social conflict, political repression and environmental hazards".[3] There is a growing recognition, reflected in many of the submissions, of the mutual interdependence between the security of individuals and communities and the security of nation States.

7. Secondly, any analysis of climate change and its impacts, including possible security implications, must grapple with uncertainty.

8. While climate modelling has made considerable advances in forecasting the future behaviour of natural systems over long time spans, the science of climate change and its physical impacts still confronts a number of uncertainties — for example, with respect to the magnitude, geographical extent and timescale of given impacts.

9. In moving from physical to social and political processes, the degree of uncertainty increases significantly. Yet, as a sustained body of information, data, and analysis becomes available, and in particular with the greater availability of geo-spatial data, the domain of uncertainty should shrink and it should become possible to assess the probabilities of different outcomes as well as the relative contributions of different factors.

10. Given both the complexity and the magnitude of the potential consequences of the relationship between climate change and security, the present report proposes two courses of action: first, to accelerate action on potential win-win options in order that the most damaging consequences can be avoided; and secondly, to focus international attention on areas where the impacts already appear highly likely, are large in magnitude, unfold relatively swiftly, have potentially irreversible consequences (the concept of "tipping points"), impose high costs on human life and well-being, and may require innovative approaches because of their unprecedented nature (for example, loss of territory and statelessness). Many share the view that it would be advisable for the international community to keep a watching brief on these and other possible security implications of climate change.

II. Channels linking climate change and security

11. Many Member State submissions recognize that the possible security implications of climate change need to be examined in the context of pre-existing social, economic and environmental threats, or stresses, which are key factors in the security of individuals, communities and States. These include the factors that were highlighted by the Millennium Summit — the persistence of poverty, hunger and disease; the rapid growth of informal urban settlements with substandard shelter and inadequate infrastructure and services; high unemployment, particularly of youth; and the growing scarcity of land, water and other resources.

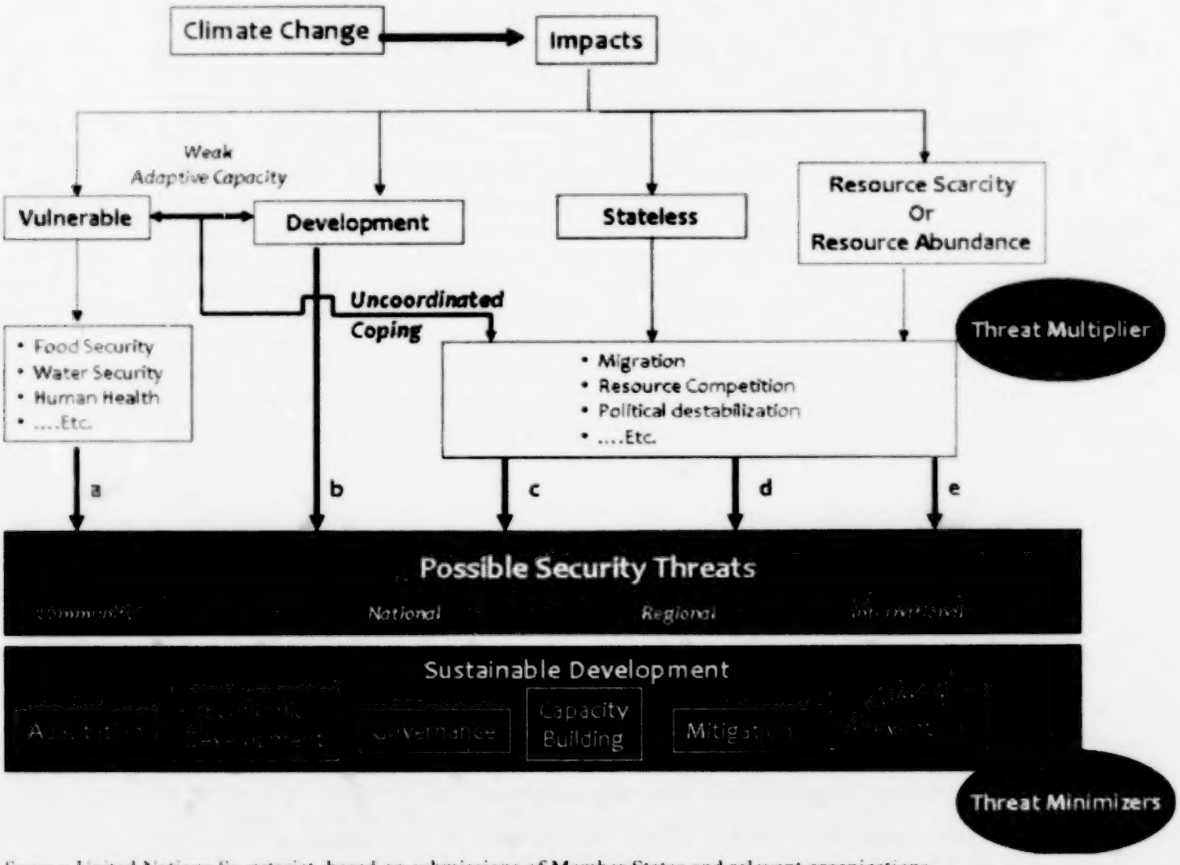
12. The magnitude of specific threats, the resilience of individuals, communities and societies and their capacity to adapt effectively to those threats — all bear on the security implications of climate change. Where climate change threats to human

[3] United Nations Development Programme, *Human Development Report 1994* (Oxford University Press, 1994), chap. 2.

well-being are expected to be severe, particularly where people are especially vulnerable because of low levels of human development and weak institutions of governance, the security implications are apt to be most pronounced, including the possibility of social and political tensions and of armed conflicts. On the other hand, many Member States have expressed the view that threats can and should be reduced through sustainable development, including legitimate and effective governance institutions, as well as peaceful dispute resolution.

13. In this regard, it is useful to think of climate change as a threat multiplier, namely as a factor that can work through several channels (see figure below) to exacerbate existing sources of conflict and insecurity. By the same token, conditions, policies, institutions and actions which serve to relieve and manage stresses effectively can be considered threat minimizers.

Threat multipliers and threat minimizers: the five channels



Source: United Nations Secretariat, based on submissions of Member States and relevant organizations.

14. The first channel runs from climate change impacts to threats to the well-being of the most vulnerable communities. Submissions in this vein sometimes identify climate change as a threat to human rights. The United Nations human rights treaty

bodies all recognize the intrinsic link between the environment and the realization of a range of human rights, such as the right to life, to health, to food, to water and to housing (see A/HRC/10/61).

15. A second channel runs from climate change impacts to economic development. From this perspective, a halt to or significant slowdown of growth caused by climate change could pose a serious security threat to developing countries, not least by worsening poverty and desperation. Growth is seen as important to strengthening resilience, maintaining political stability, increasing the attractiveness of cooperation and providing hope to underprivileged populations.

16. A third channel refers to the second-order effects of unsuccessful adaptation in the form of uncoordinated coping or survival strategies of local populations. In this context, submissions have referred to involuntary migration, competition with other communities or groups over scarce resources and an overburdening of local or national governance capacities. Such trends can manifest themselves in the form of localized conflicts or spill over into the international arena in the form of rising tensions or even resource wars.

17. A fourth channel, presented in detail in the submissions from small island developing States, runs from the threat posed by climate change to the viability and even survival of a number of sovereign States, in particular through sea-level rise and the resultant loss of national territory. Principal concerns are how to minimize the risk of such loss and how to cope with the remaining risk — of statelessness, displaced populations and territorial disputes with neighbours over exclusive economic zones.

18. A fifth channel runs from climate change to changes in natural resource availability or access and the resultant competition and possible territorial disputes between countries. This may be because of worsening resource scarcities (e.g., shared waters) or the sudden expansion of shared or undemarcated resources. In the latter category is the possibility of exploiting newly accessible natural resource deposits and transport routes through the Arctic.

19. Of these five channels, the first is well researched and documented, including by the Intergovernmental Panel on Climate Change (IPCC) Working Group II. With regard to the second channel, the relationship between development and peace was high on the research agenda in the 1960s and 1970s (under the framework of political development) but only recently has there been renewed research interest.[4] There is a general consensus in the submissions that the maintenance of global peace and stability requires the continuation of the development momentum. On the third channel, extensive research has taken place under the title of environmental security, including migration pressures and environmental stress as a source of conflict. However, while this research has improved the understanding of specific situations, it has not provided clear general conclusions. In particular, the potential linkages and interplay between climate change and security issues are mediated by a number of contextual factors — including governance, institutions, access to information and external resources and availability of alternatives. Broadly speaking, the literature reveals and several submissions recognize the need for more

[4] See P. Collier, "Development and conflict", Department of Economics, University of Oxford, 2004.

systematic research to distinguish between different causal and contextual factors and clarify policy options.[5,6]

20. There is little empirical research on the fourth channel, as it is one that poses truly unprecedented challenges to States and to the international community. Regarding the fifth channel, two observations can be made. First, the scarcity of shared resources (especially water) has often provided an incentive for transboundary cooperation. The question is how existing agreements and institutions can be reinforced so as to continue to function effectively in the face of increased scarcity. Secondly, in the case of resource abundance, there are examples of international cooperation that could be built upon, though in several countries resource abundance has been associated with domestic conflict.

21. The remainder of the report is structured around these five channels through which climate change can impact on security, namely by: increasing human vulnerability; retarding economic and social development; triggering responses that may increase risks of conflict, such as migration and resource competition; causing statelessness; and straining mechanisms of international cooperation. Section VIII looks at responses to the threats outlined in the preceding sections conceived as preventive measures designed to minimize climate change itself and its possible development and security threats. The final section suggests how the international community can prepare itself to address those serious and seemingly unavoidable threats that loom on the horizon.

III. Threats to human well-being

22. The Fourth Assessment Report of IPCC *Climate Change 2007* is an authoritative source for the science of climate change and its impacts. Yet, recent scientific literature suggests that certain impacts may be occurring at a faster rate and/or on a larger scale than is reflected in that report.[7]

23. Global mean temperature has increased by around 0.74° C over the past century, and past emissions are estimated to involve some unavoidable further warming (about a further 0.6° C by the end of the century relative to 1980-1999), even if atmospheric greenhouse gas concentrations were to remain at 2000 levels. If greenhouse gas emissions continue to rise at their current pace and atmospheric concentrations are allowed to double from their pre-industrial level, the world faces an average temperature rise of between 1.8 and 4.0 degrees Celsius this century.

24. Global average sea level rose at a rate of 1.8 [1.3 to 2.3][8] mm per year from 1961 to 2003 and at a rate of about 3.1 [2.4 to 3.8] mm per year from 1993 to 2003.

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[5] I. Salehyan, "From climate change to conflict? No consensus yet", *Journal of Peace Research*, vol. 45, No. 3 (2008). In recent years, a body of research has found a link between natural resource abundance (oil, diamonds, etc.) and violent conflict, yet the hypothesized link from climate change to conflict often runs through resource (water, land) scarcity.

[6] H. Bulhaug and others, *Implications of Climate Change for Armed Conflict*, Social Development Department, World Bank (Washington, D.C., 2008).

[7] See the proceedings of the International Scientific Congress on Climate Change, held in Copenhagen from 10-12 March 2009; Congress synthesis report available from http://climatecongress.ku.dk/pdf/synthesisreport/.

[8] Numbers in brackets represent 90 per cent confidence intervals around a best estimate. Source: IPCC Fourth Assessment Report, Synthesis Report and Summary for Policymakers.

In the past decade and a half, thermal expansion of the oceans has contributed about 57 per cent of the total sea-level rise, with decreases in glaciers and ice caps contributing about 28 per cent and losses from the polar ice sheets contributing the remainder.[9] Projections of the response of the Antarctic and Greenland ice sheets are still highly uncertain, but new research suggests sea-level rise of a metre or more by 2100.[7]

25. There is evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970, with more limited evidence of increases elsewhere. IPCC projects a likely increase in tropical cyclone activity with further warming and, with less confidence, a global decrease in tropical cyclone numbers. There will also very likely be precipitation increases in high latitudes and will likely be precipitation decreases in most subtropical land regions, continuing observed recent trends.[10]

26. The impacts of climate change on human well-being will depend in the first instance on the actions of the international community to control greenhouse gas emissions and slow climate change. It is for this reason that the world needs a climate change deal in Copenhagen that is science-based, comprehensive, balanced and equitable and fair for the future of human beings.

27. Even with an ambitious agreement, the world is already set to experience some climate change over the coming century and beyond. Without such a deal, climate change and its impacts are likely to be much farther reaching and more severe. Those impacts depend also on individuals' and communities' degree of exposure, vulnerability and adaptive capacity. Adaptive capacity in turn depends on a number of factors, including the income, health and education of the population, social capital, the effectiveness of government and other institutions, and, especially for the most vulnerable developing countries, the availability of external resources to support adaptation, as pointed out in a number of submissions.

28. The impacts of climate change on human well-being can work through several pathways, including impacts on: food production and food security, for example, linked to water scarcity, land degradation, and desertification; health and the incidence of various vector-borne diseases; the frequency and intensity of extreme weather events, including flooding, drought and tropical storms; and sea-level rise. The last two types of impact have particularly severe consequences for human settlements and population displacement. The more dependent are people on climate-sensitive forms of natural capital, the more at risk are they from climate change.[11]

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[9] Contribution of Working Group I to the IPCC Fourth Assessment Report, Synthesis Report, Summary for Policymakers, Sect. 3.

[10] IPCC Fourth Assessment Report, chap. 4, sects. 4.6, 4.8 and chap. 5, sect. 5.5.

[11] J. Barnett and W. Adger, "Climate change, human security and violent conflict", in *Political Geography: Special Issue on Climate Change and Conflict*, R. Ragnhild Nordås and N. P. Gleditsch, editors, vol. 26, No. 6 (August 2007).

29. The table below provides a summary from the IPCC Fourth Assessment Report of the major impacts of climate change.

Examples of possible impacts of climate change

Examples of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid- to late 21st century. These do not take into account any changes or developments in adaptive capacity. The likelihood estimates in column two relate to the phenomena listed in column one. (Table 3.2)

Phenomenon[a] and direction of trend	Likelihood of future trends based on projections for 21st century using SRES scenarios	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems	Water resources	Human health	Industry, settlement and society
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	*Virtually certain*[b]	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snowmelt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	*Very likely*	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g. algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas	*Very likely*	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	*Likely*	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water- and food-borne diseases	Water shortage for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases	*Likely*	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food-borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers; potential for population migrations; loss of property
Increased incidence of extreme high sea level (excludes tsunamis)[c]	*Likely*[d]	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

Source: IPCC Fourth Assessment Report, table SPM.3.

Notes:

[a] Contribution of Working Group I to the Fourth Assessment Report, table 3.7, for further details regarding definitions.

[b] Warming of the most extreme days and nights each year.

[c] Extreme high sea level depends on average sea level and on regional weather systems. It is defined as the highest 1 per cent of hourly values of observed sea level at a station for a given reference period.

[d] In all scenarios, the projected global average sea level at 2100 is higher than in the reference period. The effect of changes in regional weather systems on sea level extremes has not been assessed.

30. All of these impacts may lead to increased poverty and the reversal of development achievements, including progress towards the Millennium Development Goals. As many least developed countries are both highly exposed and highly vulnerable to climate change, and as the poor within countries are usually the most vulnerable, climate change is likely to exacerbate inequalities both between and within countries.

A. Agriculture and food security

31. Cereal productivity is expected to decrease in low latitudes (see table above), and Africa and South Asia face especially high risks of reduced crop productivity. In some African countries, yields from rain-fed agriculture could be reduced by up to 50 per cent by 2020.[12] Food security is likely to suffer and the risk of hunger to increase. Poor people in developing countries are particularly vulnerable given their dependence on agriculture for their livelihoods, often farming marginal lands. Among them, women, children, the elderly and disabled as well as indigenous people and minorities are disproportionately affected since they usually represent the most economically and socially marginalized groupings.

32. The serious impacts of the recent global food price crisis on food security and malnutrition in vulnerable countries is suggestive of what might occur, possibly on a much larger scale, in the event of future food shortages exacerbated by climate change. Social protests and unrest occurred in a number of countries and cities around the world. These impacts are not limited to changes in developing countries. One of the triggering factors in the recent food crisis was the drought and crop failure in Australia, which is not only a major world exporter of food grains but also susceptible to the impacts of climate change.

B. Water

33. According to projections, the number of people at risk from increasing water stress will be between 0.4 billion and 1.7 billion by the 2020s, between 1.0 billion and 2.0 billion by the 2050s and between 1.1 billion and 3.2 billion by the 2080s.[13] Increased water stress will be especially prominent in drylands, which are home to over 2 billion people or 35 per cent of the world's population and approximately half of all people living in poverty.[14] Water insecurity linked to climate change threatens to increase malnutrition by 75-125 million people by 2080.[15]

34. Widespread mass losses from glaciers and reductions in snow cover over recent decades are projected to accelerate throughout the 21st century, reducing water availability and hydropower potential and changing seasonality of flows in regions supplied by melt-water from major mountain ranges (e.g., Hindu-Kush, Himalaya, Andes).[15]

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[12] IPCC Fourth Assessment Report, Synthesis Report, sect. 3.3.2.

[13] B.C. Bates and others, editors, *Climate Change and Water*, IPCC Technical Paper (Geneva, June 2008).

[14] John Morton and Simon Anderson, "Climate change and agrarian societies in drylands", 2008.

[15] United Nations Development Programme, *Human Development Report 2006: Beyond scarcity: Power, poverty and the global water crisis* (2006). Available from http://hdr.undp.org/en/media/HDR06-complete.pdf.

35. Reliable access to freshwater is a necessary prerequisite for ensuring the human habitability of islands. Small-island developing States are highly vulnerable to worsening water scarcities. By mid-century, climate change is expected to reduce water resources in many small islands to the point where they become insufficient to meet demand during low-rainfall periods.[16] As shifts in rainfall patterns are expected to increase the frequency and intensity of droughts, a single prolonged drought can have serious consequences and can lead to the rapid depletion of an island's surface and groundwater resources.[17]

C. Health

36. The lack of access to safe drinking water is a major cause of morbidity and disease. According to the World Health Organization (WHO), 2.2 million people die each year from diarrhoea, mostly infants and young children. As WHO notes, higher temperatures and too much or too little water can each facilitate the transmission of diarrhoea. As noted above, climate change is expected to increase rainfall variability in some areas.

37. Besides reinforcing conditions for the transmission of diarrhoea, climate change is expected to have a number of other negative health impacts: disease susceptibility from malnutrition; death, injury and disease from extreme weather events; heat stress and cardiovascular illness from elevated ground-level ozone in urban areas; and the number of people at risk of dengue fever. There may also be positive health impacts, for example, fewer deaths from cold exposure; and mixed effects, for example, with respect to range and transmission potential for malaria.[18] Overall, it is expected that the negative effects will outweigh the positive ones, especially in developing countries.

38. The negative health effects will be felt disproportionately in sub-Saharan Africa, South Asia and the Middle East. Such health impacts in turn can reduce resilience and the capacity of individuals and communities to adapt to climate change.

D. Coastal areas, human settlements and infrastructure

39. Climate change, in particular rising sea levels, could make entire areas uninhabitable. Coastlines are particularly vulnerable to inundation and shoreline erosion, which also lead to freshwater shortages and disease outbreaks. Given that over a third of the world's population lives in coastal zones within 100 km of the shore, the effects on human settlements could be highly disruptive.[19]

40. Rapid urbanization, especially in coastal cities and cities in mega-deltas, has increased human vulnerability to climate change significantly, as underlined in a number of submissions. The number of people living in cities in developing

[16] IPCC Fourth Assessment Report, Synthesis Report, sect. 3.3.2.

[17] Contribution of Working Group II to the IPCC Fourth Assessment Report, chap. 16, executive summary.

[18] IPCC Fourth Assessment Report, Synthesis Report, sect. 3.3.1.

[19] UNEP, *Marine and Coastal Ecosystems and Human Well-Being: A synthesis report based on the findings of the Millennium Ecosystem Summit* (2006).

countries is predicted to rise from 43 per cent in 2005 to 56 per cent by 2030.[20] Millions more people than today are expected to be flooded each year by 2080.[21] In Asia, the coastal and poor mega-cities of Chennai (2005: population 6.9 million), Dhaka (12.4 million), Karachi (11.6 million), Calcutta (14.3 million) and Mumbai (18.2 million) are located only a few metres above sea level. In West Africa, the 500 km of coastline between Accra (Ghana) and the Niger delta (Nigeria) is expected to become a continuous urban megalopolis of more than 50 million inhabitants by 2020.[22] In North Africa, the Nile Delta is one of the most densely populated areas of the world and is highly vulnerable to sea-level rise.

41. The new migrants from rural areas are usually poor and many live in substandard housing in informal settlements, often on fragile hillsides or riverbanks that are highly exposed to extreme weather events (see A/HRC/10/61). The most direct risks are from flooding and landslides as a result of increases in rainfall intensity and from sea-level rise and storm surges in coastal areas.[23]

42. Sea-level rise from climate change is projected not only to expose coastal areas to increased risks, including coastal erosion and flooding, but also to cause loss of habitat and livelihood for people. One recent study of sea-level rise and storm surges finds very heavy potential losses associated with a 1-m sea-level rise and storm surges concentrated in a few countries within each region, with highly vulnerable cities clustered at the low end of the international income distribution.[24]

43. Extreme weather events such as tropical storms, together with sea-level rise, will increase the risk of damage to coastal infrastructure and productive assets. Saltwater intrusion may not only damage arable land but also threaten water supplies. The degradation of coastal ecosystems owing to climate change, such as wetlands, beaches and barrier islands, removes the natural defences of coastal communities against extreme water levels during storms. One quarter of Africa's population is located in resource-rich coastal zones and a high proportion of gross domestic product is exposed to climate-influenced coastal risks.[25]

44. In small island developing States, sea-level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, threatening vital infrastructure, settlements and facilities that support the livelihoods of island communities.[26] In the Caribbean and Pacific islands, more than 50 per cent of the population lives within 1.5 km of the shore. Almost without exception, international airports, roads and capital cities in the small islands of the Indian and Pacific Oceans and the Caribbean are sited along the coast, or on tiny coral islands.[27]

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[20] *World Population Prospects: the 2004 Revision* (United Nations publication, Sales No. E.05.XIII.6); and *World Urbanization Prospects: the 2005 Revision*, Department of Economic and Social Affairs Population Division, Working Paper No. ESA/P/WP/200 (2005).

[21] IPCC Fourth Assessment Report, Synthesis Report, sect. 3.3.1.

[22] *World Urbanization Prospects: the 2005 Revision*, see note 20 above.

[23] Contribution of Working Group II to the IPCC Fourth Assessment Report, chap. 7, sect. 7.1.4.

[24] S. Dasgupta and others, "Sea-level rise and storm surges: a comparative analysis of impacts in developing countries", World Bank Policy Research Working Paper 4901, April 2009.

[25] Contribution of Working Group II to the IPCC Fourth Assessment Report, chap. 6, sect. 6.4.2.

[26] IPCC Fourth Assessment Report, Synthesis Report, sect. 3.3.2.

[27] Contribution of Working Group II to the IPCC Fourth Assessment Report, chap. 16, executive summary.

IV. Threats to economic development

45. Several submissions highlighted that climate change can cause a number of economic disruptions, negatively impacting growth, eroding the revenue base of Governments and undermining governance capacities. It may negatively affect an economy's output, as with crop losses from drought or flooding. Through its effects on nutrition and health, it may diminish human and animal productivity. It may also contribute to land degradation and cause damage to other natural capital — for example, in coastal areas — and man-made infrastructure such as roads, ports, power grids, and so forth, diminishing an economy's productive potential.

46. Economies that are most heavily dependent on their primary sectors — notably agriculture, fisheries and forests — and those tropical countries which depend heavily on tourism, notably the small-island developing States, are most exposed to negative economic impacts.

47. Larger, more developed and diversified economies are better able to absorb climate impacts because the economic output of sectors and locations with low levels of vulnerability to climate change greatly exceeds that of sectors and locations with high levels of vulnerability.[28] The same is not true of smaller, less diversified economies, where a larger share of the economy may be vulnerable to climate impacts. [28]

48. For developing countries relying on a limited number of primary products at risk from climate impacts — for example, single crop agriculture and fisheries, declining productivity of those sectors will have an adverse impact on growth prospects. [28] One study suggests, for example, that a temperature increase of 2 °C could render much of Uganda's Robusta coffee-growing area unsuitable for coffee cultivation.[29]

49. Sea-level rise, increased risk of extreme weather events and damage to coral reefs and other coastal ecosystems will have an adverse effect on tourism and fisheries, on which many small-island developing States and other developing countries depend economically.[30]

50. The impacts of climate change on international trade remain speculative but could be significant. Rising sea-levels could require heavy investment in flood defences around ports and major industrial installations located near such deep-water ports may need to be relocated inland. Stronger winds, storm surges and rainfall point to the need for sturdier ships and offshore oil and gas installations.[31] All these factors are likely to raise transport costs. On the other side, the melting of Arctic ice and the opening of hitherto non-navigable sea lands could lower those costs for high-latitude countries.

51. For those developing countries whose economies depend heavily on natural capital adversely impacted by climate change, government finances would likely be

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[28] Ibid., chap. 7, sect. 7.4.1.

[29] O. Simonett, "Potential impacts of global warming", Global Resource Information Database (GRID)-Geneva, case studies on climatic change, Geneva, 1989.

[30] Where climate-related risks are still insurable, the costs of such insurance will rise and, for high-risk environments, insurance may no longer be available in future. In developing countries, it us not available even today for many economic activities at risk.

[31] *The Stern Report*, note 2 above, box 5.7.

diminished. In extreme cases, this could undermine institutional capacities and the provision of core public services. As several submissions have pointed out, in the case of countries characterized by fragile States and internal tensions, increased climate-induced environmental stress could overstretch existing coping strategies and, in combination with a number of political, economic, and societal factors, could result in: (a) growing tensions over increasingly scarce natural resources; (b) decreased State authority and increased risk of domestic strife;[6] and (c) political instability and radicalization.

52. Areas for further research include the degree of exposure of different economies to climate change damages, the dependence of States on revenues gained from climate-sensitive natural resources (agriculture, fisheries, forestry), and the determinants of an economy's capacity to diversify.[11]

V. Threats from uncoordinated coping

53. Much of the concern for the security implications of climate change relates to the possible consequences of large-scale and/or rapid disruptions to economies, societies and ecosystems. In that event, adaptive capacities of individuals, communities and even nation States may be severely challenged if not overwhelmed. In that event, uncoordinated coping and survival strategies may come to prevail, including migration and competition for resources, possibly increasing the risks of conflict. As the research shows and submissions acknowledge, it is not possible to say with a high degree of confidence whether and when climate impacts might induce large-scale involuntary migration and/or violent conflict. It depends on many complex local conditioning factors.

A. Population displacement and involuntary migration

54. For millennia, migration has been a human adaptive strategy in the face of poverty, resource scarcity, ethnic or religious tensions, violent conflict or other push factors. Local environmental change is another push factor. Although economic and political factors are the dominant drivers of displacement and migration today, climate change is already having a detectable impact.[32] The scale of migration and displacement, both internal and cross-border, is expected to rise with climate change, as is the proportion of population movements considered "involuntary". However, estimates of the number of people who may become migrants as a result of climate change cover a wide range and are highly uncertain.[33] Forecasts of the number of persons that may have to migrate owing to climate change and environmental degradation by 2050 vary between 50 million and 350 million.[34]

55. In the foreseeable future, the majority of those displaced by the effects of climate change, whether as the result of sudden-onset hydro-meteorological

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[32] K. Warner and others, *In Search of Shelter: Mapping the Effects of Climate Change on Human Migration and Displacement*, May 2009, report for the United Nations University Institute for Environmental and Human Security, CARE, Center for International Earth Science Information Network of Columbia University, UNHCR and the World Bank.

[33] Contribution of Working Group II to the IPCC Fourth Assessment Report, box 7.2.

[34] International Organization for Migration, *Policy Brief*, "Migration, climate change and the environment" (May 2009).

disasters or environmental degradation, are likely to remain within the borders of their country of origin. However, some displacement will also take place across internationally recognized national borders.[35]

56. The bulk of climate change-related human displacement and migration, especially that resulting from loss of arable land and/or water, will add to the number of urban dwellers in developing countries. The challenges to urban adaptation are, therefore, likely to increase substantially as are, if left unattended, the vulnerabilities of poor urban residents.

57. As noted in several submissions, in the case of small island developing States, the adverse impacts of climate change are already increasing the rate of domestic migration and relocation, with people from rural areas and outlying islands moving to urban centres as they lose their livelihoods and lands owing to natural disasters and sea-level rise. This migration is placing enormous strains on food, housing, education, health, and water supplies, as recipient communities struggle to accommodate the number of people migrating. Recent examples of internal relocation include the settlement of Lateau, in the northern province of Torba in Vanuatu, which had to be relocated because of rising sea levels. Further relocations have happened in the Federated States of Micronesia, Papua New Guinea, Tuvalu and the Solomon Islands.

58. The future prospect of large-scale climate-related migration and displacement, however uncertain, raises the issue of how those affected are to be treated under international humanitarian law. Presently, no internationally accepted term or legal framework exists for people who migrate voluntarily or are forced to move for environmental reasons. Although terms such as "environmental refugee" or "climate change refugee" are commonly used, they have no legal basis.

59. Arguably, article 33 (1) of the 1951 Convention relating to the Status of Refugees prohibits a State from forcing people who move owing to environmental factors to return to their original State, or denying them entry at the border, if their life would be threatened as a consequence. However, this principle of international law does not provide for an indefinite right to stay in the admitting State. Thus a new and climate-focused legal framework would be necessary to protect persons displaced by climate change, especially when there may be no home territory to which to return, as with submerged island States (see box III).

60. Displaced persons who remain within their own country qualify as "internally displaced persons", and the 1998 United Nations Guiding Principles on Internal Displacement (Guiding Principles) provide the normative framework for addressing protection challenges in situations of internal displacement. The Guiding Principles define "internally displaced persons" as "persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of natural or human-made disasters, and who have not crossed an internationally recognized State border".

[35] Office of the United Nations High Commissioner for Refugees, "Forced displacement in the context of climate change: challenges for states under international law", paper submitted to the Ad Hoc Working Group on Long-Term Cooperative Action under the United Nations Framework Convention on Climate Change, 2009.

61. There are many cases of mass population movements owing to climate variability, particularly in Africa (Sahel, Ethiopia) but also in South America (Argentina, Brazil), and in the Middle East (Syrian Arab Republic, Islamic Republic of Iran). One recent study analysing 38 cases since the 1930s in which environmental factors played a role in mass migration and displacement concludes that 19 of them resulted in some form of conflict.[36] The study states that environmental factors that "push" people to migrate include degradation of arable land, droughts, deforestation, water scarcity, floods, storms and famines. The study also acknowledges that the environmental factors do not work in isolation, but can contribute to a pre-existing migration flow. Conflict may arise when migrants, particularly those of a different nationality or ethnicity, move quickly or in large numbers into neighbouring States that are either already suffering from conflict or have limited resources and coping mechanisms. Tension can also mount when an influx of migrants contributes to alterations in habitat and resource availability in receiving areas and when grievances of environmentally vulnerable communities in those areas go unanswered.[37] Property claim disputes and increased demands on limited publicly funded health and social systems can also generate frictions.

62. A study of civil wars between 1945-2005 finds that, of 103 ethnic conflicts, 32 involved violence between members of a regional ethnic (minority) group that considers itself to be the indigenous "sons-of-the-soil" and recent migrants from other parts of the country.[38] While the motives of these migrations are various, the negative dynamic between migrants and indigenous groups raises concerns in the event of intensified climate-induced migration.

63. Societies differ greatly in their capacity to manage population movements and assimilate migrants, and a capacity adequate to manage moderate and/or gradual flows may be overwhelmed by massive and/or sudden flows. Adequately planning for and managing environmentally induced migration will be critical.[37] For sending communities, the loss of human capital that can accompany such outward migration may leave them unable to maintain basic social services and productive activities. These constraints can in turn lead to further migration pressures.[37]

B. Threat of intra-State conflict

64. The empirical evidence on the relationship between climate change and conflict remains sparse and largely anecdotal. This is beginning to change, as researchers link climate models and conflict models. Still, modelling climate change accurately at a fine-grained geographic scale remains a major challenge. Likewise with conflict, even with improved models and data, it remains very difficult to predict conflict occurrences and events.

65. As climate change is expected to affect rainfall variability, water resource availability, land degradation and land availability, studies often look for historical evidence of a significant link between these and different types of conflict or violence — including inter-State conflict and violence within borders of different

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[36] R. Reuveny, "Climate change-induced migration and violent conflict", in *Political Geography*, see note 11 above.

[37] International Organization for Migration, Discussion note: Migration and the Environment (MC/INF/288), November 2007.

[38] J. D. Fearon and D. D. Laitin, "Sons of the soil, migrants and Civil War", Stanford University.

kinds: one-sided violence, intra-State violence between groups, and unorganized violence.[39] A variety of local socio-economic, environmental and political factors, including adaptive capabilities, condition the results.

66. One recent empirical study of climate change and conflict using geo-referenced data finds that water and land scarcity are only weak predictors while high population density is a consistently strong predictor of armed conflict. Also, the interaction between population growth and water scarcity proves to be significant.[40] Still, political instability and other factors appear to be more important predictors of conflict.

67. That said, the fact that quantitative studies fail to confirm statistically significant links between environmental factors and conflict does not mean they do not exist. Rather, environmental factors may exacerbate conflict dynamics and risk through multiple and indirect pathways, interacting in complex ways with social, political, and economic factors, which tend to be more direct and proximate drivers of armed conflict.

68. A recent United Nations Environment Programme (UNEP) study[41] highlights that the potential consequences of climate change for water availability, food security, prevalence of disease, coastal boundaries, and population distribution may aggravate existing tensions and generate new conflicts.[42]

Box I

Climate change and security in Africa

Africa will be hard hit by climate change. Projected climatic changes for Africa suggest a future of increasingly scarce water, falling agricultural yields, encroaching desert and damaged coastal infrastructure. The continent, with the largest share of least developed countries, is less endowed than other regions with the adaptive capacities — technology, institutions, and financial resources — to buffer and cope with climate impacts.

Africa is often seen as a continent where climate change could potentially intensify or trigger conflict. Among the reasons given are the continent's reliance on climate-dependent sectors (such as rain-fed agriculture), recent ethnic and political conflict, and fragile States. Africa is also undergoing extremely rapid urbanization and population growth — already home to 14 per cent of the world's human population, a figure that is projected to rise to 25 per cent by 2050.

The continent is entering a demographic transition, with a large share of young persons in the population. In other regions, for example, Asia, this transition has helped to drive the process of economic growth

[39] Special issue of *Political Geography*, vol. 26, No. 6 (2007), on climate change and conflict contains a number of important empirical contributions.

[40] C. Raleigh, H. Urdal, "Climate change, environmental degradation and armed conflict", in *Political Geography*, see note 11 above.

[41] UNEP, *From Conflict to Peacebuilding: The Role of Natural Resources and the Environment* (Nairobi, 2009), *Executive summary*, p. 5.

[42] UNEP, *Sudan: Post-Conflict Environmental Assessment* (Nairobi, 2007).

and industrialization. For that to happen, millions of jobs will need to be created each year for the rapidly growing ranks of urban youth. Will Africa follow this path, or will these rapid changes, combined with climate shocks, provide more fertile ground for insecurity and conflict?

69. More than one sixth of the world's population currently lives in areas that rely for their freshwater supplies on glacier and snow melt-water from major mountain ranges (for example, Hindu-Kush, Himalaya, Andes).[43] As explained above, climate change is projected to affect negatively water availability in those areas over the twenty-first century. In the Andean region, for instance, there is concern that the decline of freshwater supply brought about by melting glaciers may spark tension and social unrest, based on what has happened in the past.

Box II

Melting of the Himalayan glaciers

The Himalayas, called the "Water Tower of Asia", have the largest concentration of glaciers outside the polar caps. The glacier-fed rivers originating from the Himalaya mountain ranges surrounding the Tibetan Plateau comprise the largest river run-off from any single location in the world.[44] The rivers that drain these mountains move through some of the most populous areas in the world. In the year 2000, the river basins of the Indus, Ganges, Brahmaputra, Irrawaddy, Salween, Mekong, Yangtze, and Huang He (Yellow) Rivers collectively supported a population of 1.4 billion people, or almost a quarter of the world's population.

Himalayan glaciers are already in retreat.[45] Their dependence on glacier run-off makes downstream populations particularly vulnerable to the consequences. The Indus River valley supports one of the largest irrigation works in the world. Approximately 90 per cent of Pakistan's crop production is grown under irrigation, and all of the water comes from barrages along the Indus. The Ganges, Yangtze, and Yellow Rivers also have large areas under irrigation.

It is suggested that the accelerated melting of glaciers will cause an increase in river levels over the next few decades, initially leading to higher incidence of flooding and land-slides.[46] But, in the longer-term, as the volume of ice available for melting diminishes, a reduction in glacial run-off and river flows can be expected.[47] In the Ganges, the loss of glacier melt-water would reduce July-September flows by two thirds,

[43] IPCC Fourth Assessment Report, Synthesis Report, sect. 3.3.1.

[44] UNEP-GRID Arendal Map Gallery. Available at http://maps.grida.no/go/graphic/water-towers-of-asia-glaciers-water-and-population-in-thegreater-himalayas-hindu-kush-tien-shan-tib.

[45] N. Kehrwald and others, "Mass loss on Himalayan glacier endangers water resources", *Geophysical Research Letters*, vol. 35, No. 22, 2008.

[46] IPCC, *Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report*.

[47] Z. Wanchang and others, "A monthly stream flow model for estimating the potential changes of river runoff on the projected global warming", *Hydrological Processes*, vol. 14, No. 10 (2000).

causing water shortages for 500 million people and 37 per cent of India's irrigated land.[48] Should flow reductions become acute, the potential for mass migration out of irrigated areas could be significant.[49]

70. One major study[50] identifies three regions in which increased migration induced by climate change could pose the risk of heightened tensions and conflict: South Asia (in particular low-lying and densely populated Bangladesh), sub-Saharan Africa (in particular Nigeria, where migration may lead to exacerbation of the conflict in the Niger delta, and East Africa, where migration would take place in a context of weak and failing states and a range of unresolved political issues) and Europe (with respect to an expected upsurge in immigrants from other regions, exacerbating existing tensions).

VI. Threat of loss of territory and statelessness

71. In the case of some small island developing States, sea-level rise presents perhaps the ultimate security threat, jeopardizing the very existence of small low-lying countries such as the Maldives, where 80 per cent of land is less than one metre above sea level[51] and could therefore disappear over the next 30 years. In 2005, Papua New Guinea's Carteret Islands reportedly became the first low-lying islands to evacuate their population because of climate change, resettling 2,600 islanders to the larger Bougainville Island.[34] The Carterets are among the hardest hit islands in the Pacific and may be completely submerged by as early as 2015. Given the particular vulnerability of Pacific small island developing States, a single extreme weather event can suddenly exceed a nation's capacity to respond, rendering whole islands, particularly low-lying atolls, uninhabitable.[52] Many island States face the prospect of loss of significant amounts of territory to sea-level rise and inundation, and some face the prospect of complete submersion, with the resultant threat of statelessness of their populations.

72. In view of the fact that statelessness has not yet arisen, however, the international law principle of prevention of statelessness would be applicable and the threats implied by mass statelessness for the concerned populations could be minimized. Multilateral comprehensive agreements would be the ideal preventive mechanism, providing where, and on what legal basis, affected populations would be permitted to move elsewhere, as well as their status.[53]

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[48] WWF Nepal Programme, "An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts in Nepal, India and China", 2005.

[49] Asia: Glacier melt and irrigated agricultural systems, in *In Search of Shelter*, note above, sect. 3.1.

[50] K. Campbell and others, The Age of Consequences: The Foreign Policy and National Security Implications of Global Climate Change (Washington, D.C., Center for Strategic and International Studies, 2007), chap. III.

[51] UNEP, "Atlantic and Indian Oceans Environment Outlook" (2005).

[52] Contribution of WGII to the IPCC Fourth Assessment Report, executive summary.

[53] Office of the United Nations High Commissioner for Refugees, supported by IOM and the Norwegian Refugee Council, "Climate change and statelessness: an overview", note submitted to the Ad Hoc Working Group on Long-Term Cooperative Action under the United Nations Framework Convention on Climate Change, 2009.

Box III

Small island developing States and international legal issues regarding statelessness

Islands becoming uninhabitable or disappearing as a result of sea-level rise raise the issue of the legal status of the citizens and legal rights of these States, including over fisheries.

With the disappearance of territory, one of the key constituting elements of statehood, it is not clear that these States would continue to exist as such. The same would apply if the territory would be uninhabitable to such an extent that the entire population and the Government would be forced to relocate to other States. In the event that statehood is deemed to have ceased in such a scenario, the populations concerned would be left stateless unless they acquired other nationalities. Even where the States continued to exist in legal terms and their Governments attempted to function from the territory of other States, it is unclear that they would be able to ensure the rights which flow from citizenship.

Legal and political arrangements may be necessary for the protection of affected populations. One option is the acquisition of land within another State, by purchase or a treaty of cession. There is precedence for such an option: in the late nineteenth century, many Icelanders left Iceland for environmental and social reasons. They entered into an agreement with the Canadian Government and were given land in which they could form a provisional Government, and were given both Canadian and Icelandic citizenship. Eventually, the settlement was fully integrated into Canada. This example shows that there are international mechanisms by which stateless migrants can be protected and accommodated.

73. Climate change poses a fundamental threat to cultural survival for those societies whose territories and ways of life are threatened by sea-level rise and inundation, as noted by small island developing States. Some Member States have noted that other cultures, for example, those of indigenous peoples, may be at risk from destruction or radical alteration of ecosystems and habitat by climate change. Such peoples may also face challenges in using migration as a coping strategy as a result of discrimination in receiving locations.[54] Thus the impacts of climate change on vulnerable societies will need to be addressed not only as an issue of sovereignty and statelessness but also as a threat to cultural identity.[54]

[54] M. Macchi and others, "Indigenous and Traditional Peoples and Climate Change", IUCN Issues Paper, March 2008.

VII. Threats to international cooperation in managing shared resources

74. Climate change has potential for affecting international relations among countries through possible conflicts of interest over the use of transboundary water or other resources that become increasingly scarce as a result of climate change. The need to share common waters has historically tended to foster cooperation among States, even those which may be historical rivals (e.g., South Asian countries sharing major river basins such as the Indus, Ganges and Brahmaputra, and African countries sharing the Nile and Zambezi). There is thus some basis for optimism that inter-State cooperation could be reinforced by the challenges posed by climate change, but there is also concern that intensified scarcity could impose heavy strains on such cooperation.[55]

Box IV
The Indus Waters Treaty

A water-sharing treaty of the Indus System of Rivers was signed between India and Pakistan in 1960. The treaty has survived two major wars between the rivals and governed the sharing of a strategic river.[56]

Today, both countries are plagued by water stress — strained by demand from booming populations — and there is increased competition for the Indus' dwindling resources. While the major river basins in South Asia are all vulnerable to the unpredictable effects of climate change, the Indus' flow is uniquely dependent on the seasonal runoff from shrinking Himalayan glaciers. This poses new challenges for cooperation under the Indus Treaty, and efforts will be needed at all levels to ensure its continued effectiveness.[57]

75. Rising sea levels and submersion of large areas will result in the loss of territory, including the loss of entire low-lying islands leading to forced population relocation, possible statelessness (see box IV above), and disputes over territory that have to be dealt with within the realm of international law. This could impact current disputes over maritime sovereignty, such as in the South China Sea, and could create new ones.

76. Rapidly receding Arctic sea ice could enable access to previously inaccessible natural resource deposits and maritime transport routes.

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[55] S. Hazarika, "South Asia: sharing the giants — water sharing of Indus, Ganges and Brahmaputra Rivers", *UNESCO Courier* (October 2001).

[56] W. Wheeler, "The Water's Edge", *GOOD Magazine* (July 2009).

[57] W. Wheeler and A.-K. Gravgaard, "South Asia's troubled waters", dispatches from the Pulitzer Center on Crisis Reporting, 2009.

Box V

Legal and security implications of melting Arctic sea ice

The rapid melting of the Arctic sea ice may create new challenges for the health and security of Arctic ecosystems and indigenous peoples. It has stimulated interest in exploiting the potentially significant oil and gas resources that may become accessible, as well as in opportunities presented by the opening of new shipping routes. There are potentially overlapping claims to economic rights over certain areas of the Arctic seabed. The United Nations Convention on the Law of the Sea provides the legal framework for the establishment of maritime zones, including the delineation of the outer limits of the continental shelves of coastal States, where those shelves extend beyond 200 nautical miles.

There are presently some unresolved disputes among a number of Arctic States as to the legal status of certain shipping routes. The current legal framework is well developed and nearly universally adhered to and recognized. The Arctic States are also Member States to the Arctic Council, which provides a forum for discussion and fosters the process and spirit of cooperation. Cooperation could be further strengthened.

VIII. Preventing and responding to emerging threats

77. If climate change acts as a threat multiplier, then what are the threat minimizers? Broadly speaking, there are five which emerge from the submissions: effective international and national mitigation actions, supported by finance and technology flows from developed to developing countries; strong support to adaptation and related capacity-building in developing countries; inclusive economic growth and sustainable development, which will be critical to building resilience and adaptive capacity; effective governance mechanisms and institutions; and timely information for decision-making and risk management. International cooperation will also need to be reinforced to address transboundary effects and to prevent and resolve climate-related conflicts in accordance with the Charter of the United Nations. Most submissions highlight the central role of sustainable development in enhancing adaptive capacity and as the overarching framework to address existing vulnerabilities that may be exacerbated by climate change.

A. Mitigation

78. IPCC finds that achieving greenhouse gas stabilization levels associated with holding the global mean temperature increase below 2-2.4°C will require that emissions peak by 2015 and decline steeply thereafter, with a decline in emissions relative to 2000 levels of 50-85 per cent by 2050.[58] Some of the most vulnerable countries have criticized a 2°C target as not ambitious enough. They are already

[58] New science suggests that a percentage reduction at the lower end of the range is very unlikely to keep temperature rise below 2° C.

suffering the effects of sea-level rise owing to the present temperature increase and are likely to lose some of their territories under a 2°C scenario. Clearly, stringent emission reductions are required to keep temperature increases as low as possible. This will require much greater levels of ambition than are currently evident from the sum total of national actions.

79. It is critical that Member States take action to address climate change in ways that bolster security and strengthen the multilateral system. First and foremost, this requires reaching a comprehensive, fair and effective deal in Copenhagen that will help to stabilize our climate; catalyse the transformation to clean energy, lower-emissions economies; protect development gains; assist vulnerable communities in adapting to climate impacts; and build more secure, sustainable and equitable societies. Failure to deliver progress on what is now widely perceived as the defining challenge of our age may risk undermining confidence in the multilateral system more broadly.

80. Mitigation on the scale needed will require, inter alia, moving swiftly towards low-carbon energy sources, as well as major advances in energy efficiency and conservation, and a dramatic slowing in deforestation rates. All this must be achieved while ensuring that the many millions of poor people currently without access to modern energy services are able to afford access to them. Several Member States have emphasized that technology transfer and financial assistance from developed countries are vital to enable developing countries to move swiftly towards low-carbon development.

B. Adaptation

81. Adaptation involves making people secure and safeguarding social and economic development in the face of climate change threats. Key elements include food security, health and safety. Adaptation requires empowering people, building their resilience, securing livelihoods, and putting in place or strengthening the physical infrastructure to protect against extreme weather events as well as the institutions and systems needed to cope with their consequences. Effective adaptation will require not only effective local action but also national coordination, supported by vigorous international cooperation and, in the case of vulnerable developing countries, by adequate resources from developed countries.

82. Critical actions to enhance food security in vulnerable environments include: developing new drought- and heat-tolerant crop varieties; conserving and better managing scarce water resources; combating land degradation and soil erosion; reducing the loss of biodiversity and ecosystem services.[59] Promoting sustainable agricultural practices that sequester carbon in the soil is particularly promising because it simultaneously mitigates climate change while increasing agroecosystems' resilience and protection against extreme weather events and declines in farm productivity. Because poor farmers in the tropics will be disproportionately affected by climate change, low-cost and effective practices that sequester soil carbon can also contribute to food security and poverty alleviation.

[59] FAO, "Climate change and adaptation and mitigation in the food and agricultural sector", technical background document for the expert consultation held from 5-7 March 2008 of the High-Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy, p. 4.

83. The actual impact of climate change on human health and well-being will depend critically on the performance of public health systems and other supporting infrastructure, especially in developing countries. Improved climate-sensitive disease surveillance is critical to measure, evaluate, anticipate and respond to the effects of climate on health.[60] Public awareness, the effective use of local resources, adequate funding, appropriate governance arrangements and community participation are necessary to mobilize and prepare for impacts of climate change on public health systems.[61]

84. Tackling the threat of climate change in risk-prone areas will need a strengthening of disaster risk management, risk reduction and preparedness. Policies outlined in the Hyogo Framework[62] address issues related to disaster risk reduction, which are relevant in the adaptation context. Given the high exposure of coastal areas to climate risks, integrated coastal and marine resource management is a valuable approach to building resilience and strengthening natural defences against storm surges. Regional and international insurance or financing facilities to help countries hit by natural disasters are relatively new[63] and their further development warrants consideration.

C. Economic growth and sustainable development

85. Sustaining economic growth is essential to strengthening resilience and ensuring that developing countries and their people are adequately equipped to adapt to climate change. Broad-based economic growth also tends to foster social cohesion and limit risks of social conflict. Any serious compromise of national or subnational growth prospects from climate change could, in some situations, increase risks of social discord and conflict. Therefore, many Member States place great importance on "climate-proofing" economic development, to minimize the chances that climate change will interfere with economic progress and the attainment of the internationally agreed development goals as well as the maintenance of social and political stability.

86. Several submissions highlight the importance of integrated climate change policymaking that cuts across economy, society and the environment and across all sectors, and the mainstreaming of climate change into economic development and sustainable development plans and policies and poverty reduction strategies, ensuring that climate change considerations are built right into the foundations of plans to reach the Millennium Development Goals.

87. For some countries, in particular low-lying atolls, inundation and the loss of land from sea-level rise pose a potential threat to the continued existence of the States themselves. The potentially affected Member States have put forward the

[60] IPCC Fourth Assessment Report, Synthesis Report, table 4.1; and K. L. Ebi (2008), "Public Health Adaptation to Climate Change in Low-Income Countries", presentation at Brookings Institution Conference, Washington, D.C.

[61] Contribution of Working Group II to the IPCC Fourth Assessment Report, chap. 8, sect. 8.6.

[62] Hyogo Framework for Action 2005-2010: Building the Resilience of Nations and Communities to Disasters, adopted at the World Conference on Disaster Reduction, Kobe, Japan, 18-22 January 2005.

[63] The African, Caribbean and Pacific States-European Union Natural Disaster Facility and Caribbean Catastrophe Risk Insurance Facility are two such initiatives.

view that, for them, no amount of sustainable development can protect against the security implications of climate change and that development itself becomes meaningless when there is no longer any sovereign territory with which it can be associated.

D. Effective governance mechanisms and institutions

88. Factors such as governance and effective institutions at the local, national, regional and international levels are crucial in lessening any possible security risks posed by climate change.

89. Governments, in cooperation with civil society, need to ensure — and build if necessary — the capacity to lead and execute an effective and coordinated national climate change strategy. Should climate change increase resource scarcities, cause localized food shortages, and/or intensify natural disasters, this could stretch existing State capacities in many countries. Thus, many developing countries would stand to benefit from a comprehensive programme of institutional capacity-building for climate change adaptation, including institutions for prevention, mediation and the peaceful resolution of conflicts. In the absence of such institutional strengthening, and in the event of failure by Governments to respond effectively to their people's needs in the face of climate-related disasters, political legitimacy could be undermined.

90. Adaptive capacity needs to extend across all levels of government and all sectors of society. Addressing the impacts of climate change will require broad public engagement. As those impacts disproportionally affect the most vulnerable and marginalized groups in societies, it is imperative that these groups are empowered and involved in all stages of planning, decision-making and implementation of measures to tackle climate change.

E. Information for decision-making and risk management

91. Improved data and information on climate change and its impacts at the local and regional levels are needed for sound and informed decision-making on response and adaptation measures. While the scientific findings of the IPCC Fourth Assessment Report provide useful information at the global and regional level, they tend to lack the resolution and specificity required for detailed analysis and decision-making at the country or lower level. In this regard, several Member States suggest, in the context of future climate change negotiations, the establishment of a work programme to support the implementation of national adaptation programmes of action that would address research and systematic observation needs.

92. Enhanced earth observation and climate monitoring systems are essential, and there is an urgent need to make the information they produce available to decision makers in developing countries. It is important to strengthen the relevant observation networks such as the Global Climate Observing System and the ongoing work on the development of the Global Earth Observation System of Systems.

93. Technical cooperation and assistance is required to strengthen meteorological services and early warning systems, which can serve as a useful tool to help countries to respond to extreme weather events and minimize damages and loss of

human life. Integrating the hard science of climate change with local knowledge is necessary in order to provide those who are the most vulnerable with the tools needed to respond and adapt. Affordable information and communications technologies can be an effective means of getting timely information to people facing climate-related risks at the local level.

94. Finally, increased support for research and analysis on the security implications of climate change is needed, especially through stronger linkages between physical and social models.

F. Reinforcing international cooperation

95. Safely managing the multiple transboundary effects of climate change will require multilateral approaches. These will include adherence to and observance of existing frameworks, and new modes and frameworks for international cooperation as necessary. A number of areas that could require multilateral responses have been highlighted above, including the question of: migrants from climate-related causes; statelessness, including issues such as displaced persons and States' rights over maritime zones; reinforcing cooperative mechanisms to deal with changed international resource availability, as with the management of transboundary waters and of Arctic resources.

96. Experience shows, as noted above, that natural resource scarcity can foster international cooperation, and I urge Member States to look at cooperative approaches as the only way of safely managing the transboundary effects of climate change.

97. Should tensions emerge in connection with the effects of climate change — regarding, for example, water and land issues — preventive diplomacy and mediation are likely to be critical for managing the issues and fostering peaceful outcomes. Member States, regional organizations and the United Nations will have a key role in addressing dialogue and mediation needs, and supporting those efforts.

IX. The way forward

98. The international community has a number of vital roles to play to bolster security in the face of climate change. First, it must take bold action on climate change mitigation, for without slowing the rate of climate change, the threats to human well-being and security will greatly intensify. The importance to the future of the planet of forceful mitigation action cannot be overstated.

99. Secondly, the international community must provide stronger support to climate change adaptation in developing countries, including through investments in capacity-building at all levels. As the impacts of climate change range over many sectors, the support to adaptation needs to be correspondingly broad. It needs to address: water scarcity, food security and agricultural resilience; the functioning of public health systems to deal with increased disease incidence and risk; disaster prevention, preparedness and response; early warning systems at both the national and regional levels for various climate change impacts. Where national capacities are overstretched by devastating cyclones, floods, droughts or other hazard events, there will be an increasing requirement of the international community to respond.

100. Thirdly, the international community needs to redouble its efforts to ensure the sustainable and equitable development of all countries, notably through developed countries' meeting their international commitments on development assistance. This is all the more imperative in the midst of the current global economic difficulties, which have threatened to set back the development progress of recent years in many developing countries. Continued economic growth is important to minimizing vulnerabilities to climate change. As the present report has repeatedly stressed, poor countries are among the most vulnerable, and the best way to reduce their vulnerability is to help to lift them out of poverty. Moreover, developing countries will need firm international financial and technological support to facilitate their development along a low-carbon path.

101. Fourthly, the international community must anticipate and prepare itself to address a number of largely unprecedented challenges posed by climate change for which the existing mechanisms may prove inadequate:

- One is the possibility of large numbers of persons displaced across borders by climate change, which existing international law cannot adequately address, especially if they have no country to which to return.
- A second is the prospect of "statelessness" of citizens of submerged island nations, which raises important legal issues concerning national sovereignty, claims over marine resources, and the rights and relocation of citizens of such territories. Legal and political arrangements may be necessary for the protection of affected populations.
- A third is the prospect of the drastic reduction in water availability to hundreds of millions of the world's people as a result of the melting of mountain glaciers and snow pack. How can neighbouring countries dependent on the same water sources sustain and even strengthen their cooperative management of shared waters in the face of these challenges, and what support can the international community provide?
- Finally, there is the prospect of intensified competition over newly accessible Arctic natural resources and trade routes. An institutional framework exists that could be strengthened, or new cooperative arrangements forged.

102. Climate change is a global challenge that can only be tackled at a global level. Several submissions of Member States stress that there is an opportunity to increase policy coherence and cooperation across the United Nations system, as well as with other relevant organizations. The efforts to mainstream climate change within United Nations activities must continue and be strengthened. There is a need to improve the flow of information and sharing of assessments, particularly on early warning, between different regional and international organizations. The United Nations system may also need to review further and enhance its capacity to respond to an anticipated growth in disasters and humanitarian crises related to climate change.

103. All the submissions agree that the United Nations Framework Convention on Climate Change remains the central United Nations body responsible for conducting climate change negotiations. Beyond that, Member States express a variety of views on institutional questions, which can be found in their submissions on the website of the Department of Economic and Social Affairs Division for Sustainable Development (http://www.un.org/esa/dsd/resources/res_docugaecos_64.shtml).

104. A number of submissions highlight the need for further research to shed clearer light on causal pathways and conditioning factors that may help to explain why, in different situations, broadly similar physical impacts of climate change may have very different implications for human well-being and security. How likely are climate change impacts, in a given context, to give rise to migration pressures, to increase social tensions and the risk of violent conflict, and to weaken the capacities of States and other institutions? What preventive measures can be taken by national Governments and civil society to minimize the threats posed by climate change to human well-being, development and security? Finally, how can the international community best prepare itself for possible emerging challenges such as large-scale population displacement, statelessness, and strains on cooperative arrangements for the management of international resources?